A Mesoscale Analysis of Column-Integrated Aerosol Properties in Northern India during the TIGERZ 2008 Pre-Monsoon Period and a Comparison to MODIS Retrievals

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The Indo-Gangetic Plain (IGP) of the northern Indian subcontinent produces anthropogenic pollution from urban, industrial and rural combustion sources nearly continuously and is affected by convection-induced winds driving desert and alluvial dust into the atmosphere during the pre-monsoon period. Within the IGP, the NASA Aerosol Robotic Network (AERONET) project initiated the TIGERZ measurement campaign in May 2008 with an intensive operational period from May 1 to June 23, 2008. Mesoscale spatial variability of aerosol optical depth (AOD, τ) measurements at 500nm was assessed at sites around Kanpur, India, with averages ranging from 0.31 to 0.89 for spatial variability study (SVS) deployments. Sites located downwind from the city of Kanpur indicated slightly higher average aerosol optical depth ($\Delta\tau_{500}$=0.03-0.09). In addition, SVS AOD area-averages were compared to the long-term Kanpur AERONET site data: Four SVS area-averages were within $\pm 1\sigma$ of the climatological mean of the Kanpur site, while one SVS was within 2σ below climatology. For a SVS case using AERONET inversions, the 440-870nm Angstrom exponent of ~0.38, the 440-870nm absorption Angstrom exponent (AAE) of 1.15-1.53, and the sphericity parameter near zero suggested the occurrence of large, strongly-absorbing, non-spherical aerosols over Kanpur (e.g., mixed black carbon and dust) as well as stronger absorption downwind of Kanpur. Furthermore, the 3km and 10km Terra and Aqua MODIS C005 aerosol retrieval algorithms at τ_{550} were compared to the TIGERZ data set. Although MODIS retrievals at higher quality levels were comparable to the MODIS retrieval uncertainty, the total number of MODIS matchups (N) were reduced with subsequent quality levels (N=25, QA≥0; N=9,QA≥1; N=6, QA≥2; N=1, QA=3) over Kanpur during the pre-monsoon primarily due to the semi-bright surface, complex aerosol mixture and cloud-contaminated pixels. The TIGERZ 2008 data set provided a unique opportunity to measure the spatial and temporal variations of aerosol loading in the IGP. The strong aerosol absorption derived from ground-based sun/sky radiometer measurements suggested the presence of a predominately black carbon and dust mixture during the pre-monsoon period. Consistent with the elevated heat-pump hypothesis, these absorbing aerosols found across Kanpur and the greater IGP region during the pre-monsoon period likely induced regional atmospheric warming, which lead to a more rapid advance of the southwest Asian monsoon and above normal precipitation over northern India in June 2008.